FORM PTO-1390 US DEPARTMENT OF COMMERCE
REV. 5-93PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEYS DOCKET NUMBER
P01,0404

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)
10/009656

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE00/01508	**12 MAY 2000**	**12 MAY 1999**

TITLE OF INVENTION

LED ARRANGEMENT

APPLICANT(S) FOR DO/EO/US

Karlheinz ARNDT, et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay.
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). **UNSIGNED**
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98; **(PTO 1449, Prior Art, Search Report, References).**
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included. **(SEE ATTACHED ENVELOPE)**
13. ☒ Preliminary Amendment
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☒ A substitute specification and substitute specification mark-up.
15. ☐ A change of address letter attached to the Declaration.
16. ☒ Other items or information:
    a. ☒ Submission of 2 sheets of Drawings
    b. ☒ EXPRESS MAIL #EL 843743719 US dated November 13, 2001

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/009656	PCT/DE00/01508	P01,0404

17. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5): Search Report has been prepared by the EPO or JPO $890.00		
International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) $710.00		
No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2) $740.00		
Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2) paid to USPTO $1040.00		
International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $ 100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).	$	

Claims	Number Filed		Number Extra	Rate		
Total Claims	17	- 20 =	0	X $ 18.00	$	
Independent Claims	01	- 3 =	0	X $ 84.00	$	
Multiple Dependent Claims				$280.00 +	$	
				TOTAL OF ABOVE CALCULATIONS =	$ 890.00	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)					$	
				SUBTOTAL =	$ 890.00	
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +					$	
				TOTAL NATIONAL FEE =	$ 890.00	
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). $40.00 per property +						
				TOTAL FEES ENCLOSED =	$ 890.00	
				Amount to be refunded	$	
				charged	$	

a. ☒ A check in the amount of $ 890.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **50-1519**. **A duplicate copy of this sheet is enclosed.**

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

SCHIFF HARDIN & WAITE
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Steven H. Noll

Signature **Steven H. Noll** **Attorney for Applicants**

Registration No. 28,982

BOX PCT

IN THE UNITED STATES DESIGNATED/ELECTED OFFICE
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY - CHAPTER II

AMENDMENT "A" PRIOR TO ACTION AND SUBMISSION OF SUBSTITUTE SPECIFICATION

APPLICANT(S):	ARDNT, et al.
ATTORNEY DOCKET NO:	P01,0404
INTERNATIONAL APPLICATION NO:	PCT/DE00/01508
INTERNATIONAL FILING DATE:	12 MAY 2000
INVENTION:	LED ARRANGEMENT

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Applicant herewith submits an amendment and substitute specification in the captioned PCT application, and respectfully requests entry of same prior to examination in the United States National Stage.

IN THE SPECIFICATION

Cancel the specification as filed, and insert therefore the Substitute Specification provided herewith.

IN THE CLAIMS

Cancel the claims as filed, and insert therefore new claims 1 - 17 as follows:

- - What is claimed is:

18. (New) A surface-mounted LED arrangement, comprising a printed

circuit board having a principal surface and a secondary surface, said printed circuit board comprising a plastic material, a plurality of LEDs arranged on said principal surface, a metallic layer provided on said secondary surface, and a cooling member connected to said secondary surface, wherein said printed circuit board is secured to said cooling member with one of a thermally conductive paste, a thermally conductive adhesive or a thermally conductive film.

19. (New) The LED arrangement according to claim 18, wherein said metallic layer comprises copper or other metal having good thermal conductivity.

20. (New) The LED arrangement according to claim 19, wherein said printed circuit board comprises a flexible printed circuit board structure, particularly a flex board.

21. (New) The LED arrangement according to claim 20, wherein said secondary side is applied to one of a curved surface, a singly angled surface or a multiply angled surface of said cooling member, or to a thermally conductive partial region of a device housing, or to an automobile chassis, such that said plurality of LEDs are arranged in a spatial form determined by said one of a curved surface, singly angled surface or multiply angled surface of said cooling member.

22. (New) The LED arrangement according to claim 21, wherein said metallic layer comprises a meander-like lateral structure.

23. (New) The LED arrangement according to claim 22, wherein said cooling member comprises a metal, particularly copper or aluminum or sheet metal.

24. (New) The LED arrangement according to claim 23, wherein a surface of said cooling member remotely positioned from said printed circuit board is blackened, comprises cooling ribs or is provided with a roughened surface.

25. (New) The LED arrangement according to claim 24, wherein said plurality of LEDs are provided with lenses.

26. (New) The LED arrangement according to claim 25, wherein said printed circuit board electrically insulates said metallic layer from said plurality of LEDs.

27. (New) The LED arrangement according to claim 26, wherein said printed circuit board comprises one of an epoxy resin, a polyester or a polyamide, preferably in the form of a polyester or polyamide film.

28. (New) A lighting device comprising the LED arrangement according to claim 27.

29. (New) The lighting device comprising an LED arrangement according to claim 28, wherein said lighting device is an exterior lighting fixture of a motor vehicle, and said cooling member comprises a curvature adapted to one of an outside contour of said motor vehicle or to a partial surface region of an automobile chassis.

30. (New) The lighting device comprising an LED arrangement according to claim 29, wherein said LED arrangement is a rotating light, and said cooling member has a cylindrical hollow shape with said printed circuit board applied to an outside wall thereof.

31. (New) The lighting device according to claim 30, said plurality of LEDs that proceed axially are electrically combined into lines that can be successively circumferentially operated.

32. (New) The lighting device having an LED arrangement according to claim 20, wherein said lighting device is an exterior lighting fixture of a motor vehicle,

and said cooling member comprises a curvature adapted to one of an outside contour of a motor vehicle or to a partial surface region of an automobile chassis.

33. (New) The lighting device according to claim 30, wherein said LED arrangement is a rotating light, and said cooling member has a cylindrical hollow shape with said printed circuit board applied to an outside wall thereof.

34. (New) The lighting device according to claim 33, wherein said plurality of LEDs that proceed axially parallel are electrically combined into lanes that can be successively circumferentially operated. - -

IN THE ABSTRACT

Cancel the Abstract as filed, and insert therefore on a separate page, the followng Abstract of the Disclosure:

- - **ABSTRACT OF THE DISCLOSURE**

An LED array surface-mounted on a circuit board and applied to a cooling member, such that any generated heat is optimally eliminated. The cooling member can be in any desired shape so that motor vehicle lights, such as blinkers, can be adapted to the outside contour of the vehicle. For a rotating light, the circuit board can be applied around a cooling member fashioned as a hollow cylindrical member which is adapted to rotate. - -

REMARKS

A substitute specification and an Abstract of the Disclosure are provided herewith which make editorial changes in order to conform to standard US practice. A marked-up version of the specification is also provided reflecting the changes made.

In addition, the claims as filed have been canceled and replaced by new claims that more clearly set forth the subject matter of Applicants' invention.

No new matter has been inserted into the application.

Applicants submit that this application is in proper condition for examination in the United States National Examination Stage, which action is earnestly solicited.

Respectfully submitted,

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BOX PCT

IN THE UNITED STATES DESIGNATED/ELECTED OFFICE
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY - CHAPTER II

SUBMISSION OF DRAWINGS

APPLICANT(S):	ARNDT, et al.
ATTORNEY DOCKET NO:	P01,0404
INTERNATIONAL APPLICATION NO:	PCT/DE00/01508
INTERNATIONAL FILING DATE:	12 MAY 2000
INVENTION:	LED ARRANGEMENT

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Applicants herewith submit two drawing sheets, showing FIGURES 1, 1A, 2A, 2B, and 2C, in the captioned PCT application.

Respectfully submitted,

Steven H. Noll

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2/pats

[Substitute Specification:]

[- -] LED ARRANGEMENT

[BACKGROUND OF THE INVENTION

Field of the Invention:]

The present] ~~{The }~~ invention is directed to ~~{an LED arrangement according to the preamble of patent claim 1 that, in particular,}~~ **[LED (light emitting diode) arrangements. In particular, the present invention is directed to LED arrangements that]**can be built into a lamp housing ~~{as can be employed, for example,}~~ **[or located]** in exterior lights of motor vehicles.

[Brief Discussion of the Related Art:]

In the field of exterior and interior illumination of motor vehicles, light-emitting diodes (LEDs) are being increasingly used instead of conventional incandescent bulbs, particularly for tail lights and brake lights, since LEDs have a longer service life, a better efficiency in the conversion of electrical energy into radiation energy in the visible spectral range and, connected therewith, a lower heat emission and a lower space requirement overall.

EP 0 253 224 discloses a method for the manufacture of a light with light-emitting diodes. The light to be manufactured comprises a soft plastic film on whose upper side a copper lamination is applied and a plurality of light-emitting diodes are arranged. The plastic film has its side lying opposite the upper side glued onto a metallic carrier plate. The light is

provided for employment in a motor vehicle, whereby the carrier plate can be implemented bent for adaptation to the shape of a motor vehicle.

Further, US 5,782,555 discloses a traffic signal light that comprises a plurality of LEDs as luminous members. The LEDs are secured on the surface of a printed circuit board that is provided with a both-sided metallization. A plurality of through holes via which the metallizations are connected to one another are formed in the printed circuit board. The printed circuit board is secured with an adhesive to a cooling member that is provided with an electrically insulating surface.

US 5,890,794 discloses another lighting unit on the basis of LEDs. Here, a plurality of radial LEDs is mounted on a printed circuit board, whereby the wire leads are conducted through the printed circuit board in a traditional way. In one illustrated embodiment, the printed circuit board is flexible and applied onto a cylindrical member. A coolant fluid is preferably employed for cooling.

A certain added outlay must be incurred first when constructing a light with LEDs since, due to the low luminance of an individual LED compared to an incandescent bulb, a plurality of LEDs shaped to form an array must be constructed.

For example, such an array can be mounted ~~[[sic] in]~~ **[using]** surface mounting technology (SMT~~[, surface-mount technology) from]~~**[) with]** a plurality of LEDs on a printed circuit board (PCB). ~~[An]~~ **[Such an]** LED structure ~~[as]~~ **[is]** described~~[, for example,]~~ in the article "SIEMENS SMT-TOPLED für die Oberflächenmontage" by F. Möllmer and G. Waitl in the

periodical Siemens Components 29 (1991), Number 4, page 147 ~~{in conjunction with Figure 1 is thereby employed}~~. The form of the ~~{LED}~~ **[LEDs]** is extremely compact and allows the arrangement of a plurality of such LEDs in a row or matrix arrangement as warranted.

However, only approximately 5% of the electrical power is converted ~~{in the form of}~~ **[into]** light within the housing of such an LED that, for example, emits yellow-colored or amber-colored light, whereas approximately 95% is converted ~~{in the form of}~~ **[into]** heat. This heat is eliminated from the underside of the chip via the electrical terminal of the component. Dependent on the structure, the heat given the components ~~{of the assignee known by the names TOPLED or Power TOPLED}~~ **[known as TOPLED® or Power TOPLED®]** is first conducted ~~{our}~~ **[out]** of the housing onto the solder points on the printed circuit board by one or three existing cathode terminals. From the solder points, the heat at first propagates in the copper pads and then on the epoxy resin material in the plane of the printed circuit board. Subsequently, the heat is output large-area to the environment by thermal radiation and thermal convection. The thermal resistance is still relatively slight in the case of a single LED on FR4 circuit board material (for example, approximately 180 K/W given an LED of the type Power TOPLED®).

The situation is different~~{,}~~ however, when many LEDs are arranged in close proximity on a circuit board. A smaller percentual area of the PCB is now available for each individual LED for ~~{the}~~ heat transmission to the environment. The thermal resistance from the PCB onto the environment is correspondingly higher. ~~{Given}~~ **[For instance, given]** a

components spacing of~~{, for example,}~~ 6.5 mm, the thermal resistance rises to up to 550 K/W when the LEDs are of the ~~{type}~~ Power ~~{TOPLED}~~ **[TOPLED® type,]** and the printed circuit board is of the type FR4.

Heat is emitted from all heat-generating components on the circuit board, i.e. from the dropping resistors, transistors, MOSFETs**[,]** or drive ICs ~~{as well,}~~ that are located in the immediate proximity of the LEDs. ~~{The operating}~~ **[Operating]** current must be reduced so that ~~{a}~~ destruction of the component does not occur as a consequence of ~~{the heat}~~ **[heat]** generation on the circuit board and ~~{the}~~ inadequate heat elimination. ~~{The}~~ **[Thus, the]** luminous power of the LEDs~~{, accordingly,}~~ cannot be fully exploited.

LED arrangements are utilized for the third brake light in the aforementioned field of motor vehicle lighting. This is a single-line array wherein the thermal problems are not yet so critical.

[SUMMARY OF THE INVENTION]

It is therefore an object of the present invention to improve an LED arrangement ~~{of the species initially cited}~~ such that the luminous power of the LEDs can be as optimally utilized ~~{as possible}~~. In particular, an object of the present invention is to specify a surface-mounted LED arrangement that is distinguished by an improved heat elimination from the LEDs. In addition, an LED arrangement should be made available with which different spatial shapes of three-dimensional lamps can be realized in a simple way.

~~{This object is achieved by an LED arrangement having the features of patent claim 1. Advantageous developments of the invention and~~

~~preferred lighting devices having inventive LED arrangements are the subject matter of patent claims 2 through 14.)~~

According to the invention, an LED arrangement with a printed circuit board and a plurality of LEDs -- surface-mounted LEDs are especially preferred -- is provided, whereby the printed circuit board has its side facing away from the LEDs applied on a cooling member and comprises a metallic layer with good thermal conductivity on this side that is electrically insulated from the LEDs by the printed circuit board. The **[present]** invention is thus based on the perception that ~~(the)~~ heat elimination toward the back must be promoted, particularly given a surface-mounted LED arrangement having a high LED density.

The cooling member can~~(, for example,)~~ be composed of copper or aluminum or of a cooling plate, and the printed circuit board is preferably secured ~~(on)~~ **[to]** it with a thermally conductive paste, a thermally conductive adhesive, a thermally **[conductive film or the like. It should enable an optimally good heat dissipation at its back side. To this end, for example, it can be painted black and/or comprise cooling ribs and/or a rough surface.**

Further, the printed circuit board should be as thin as possible since the plastic material of which it is constructed usually conducts heat poorly. For example, the printed circuit board can be a flexible printed circuit board. The flexible printed circuit board is generally manufactured of a flexible plastic. For example, it can be composed of polyester or polyamide film, or it may comprise what is often referred to

as flex-board. Flex board is generally multi-layer printed circuit boards that are uniformly constructed of a plurality of polyamide carrier films.

Further, the copper pads around the solder surfaces of LEDs applied with surface mounting technique (SMT) should be as large as possible in order to broaden the heat path through the printed circuit board material before the heat flows to the back side of the printed circuit board. Preferably, the principal face of the printed circuit board facing toward the cooling member is laminated with copper or some other metal in order to enable thermal conduction transversely to other glue] locations given cavities in the lamination. For example, the copper layer can be structured meander-shaped laterally to the printed circuit board in order to preserve the flexibility of the printed circuit board.

In an ~~{inventive}~~ **[embodiment of the]** LED arrangement **[according to the present invention]**, a cooling member having a specific three-dimensional shape is employed, and a flexible printed circuit board ~~{that has}~~ **[having]** a principal face provided with a plurality of LEDs is laminated onto the surface of the cooling member shaped or curved in this way. As a result thereof, LED modules spatially shaped on the basis of specific particulars can be manufactured. ~~{An}~~ **[For example, an]** LED module **[such]** as~~{, for example,}~~ **[a]** blinker, tail light, brake light ~~{of}~~**[, or]** the like**[,]** can be adapted to the outside contour of the vehicle in a space-saving fashion. An especially practical exemplary embodiment of this type is a rotating light wherein LED arrays on flex boards are laminated around a cylindrical cooling member.

The LED arrangement **[of the present invention]** can preferably have its printed circuit board applied on a highly thermally conductive partial surface region of a device housing or of an automobile chassis or the like. Advantageously, the device housing or~~{, respectively,}~~ the automobile chassis ~~{or the like}~~ thereby acts as cooling member. Among other things, this leads to a lower technological manufacturing outlay and to a weight-saving. ~~{These}~~ **[Thus, the thermally conductive]** partial surface region ~~{[sic] thus represents}~~ **[serves as]** the cooling member in the ~~{sense of the present invention.}~~ **[present invention.]**

~~{Further advantageous developments and preferred embodiments are explained in greater detail below on the basis of exemplary embodiments in conjunction with Figures 1A through 2C. Shown therein are:}~~ **[BRIEF DESCRIPTION OF THE DRAWINGS]**

~~{Figure 1A a side view of a basic}~~ **[Figure 1A shows a side view of an]** embodiment of the present invention ~~{wherein the printed circuit board of a surface-mounted LED arrangement is secured to a cooling member;}~~**[;]**

~~{Figure 1B a schematic illustration of a possible structure of the highly}~~ **[Figure 1B shows a schematic of an embodiment of a]** thermally conductive layer **[according to the present invention]**; and

Figures 2A-2C ~~{modified}~~ **[shows other]** embodiments of the present invention with different shapes of cooling members.

[DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

The embodiment of the present invention] ~~{The basic embodiment }~~ shown in Figure 1 contains a printed circuit board 1 on which a plurality of preferably surface-mounted LEDs 2 are applied ~~{by means of [sic]}~~. In a known way, the printed circuit board 1 thereby ~~{comprises}~~ **[forms]** a circuit that comprises terminal surfaces for the mounting of the LEDs at defined locations. These terminal surfaces are provided, for example, with lands for soldering in an automatic surface mount device (SMD) equipping unit, and the LEDs 2 have their electrical contacts 2a soldered to these terminal surfaces in a subsequent mounting step.

The printed circuit board 1 can ~~{thereby}~~ be a rigid printed circuit board, ~~{for example of the}~~ **[such as]** type FR4, and~~{, accordingly, is essentially}~~ constructed of an epoxy resin material. However, it can also be a flexible printed circuit board such as an above-described flex board. The printed circuit board 1 is laminated onto a cooling member 3 with a thermally conductive adhesive, said cooling member 3 being composed of a cooling plate or being fabricated of some other metal such as copper or aluminum**[,]** and thus exhibiting a high thermal conductivity.

The principal face of the printed circuit board 1 facing toward the cooling member is laminated with a layer 4 having good thermal conductivity, ~~{for example}~~ **[such as]** with a copper layer or some other metal layer in order to ~~{still}~~ enable thermal conduction transversely to other glue locations given cavities in the lamination. The copper layer can~~{, for example,}~~ be meander-shaped ~~{(Figure 1B)}~~ **[as shown in Figure 1B]** in order to preserve the flexibility of the printed circuit board.

~~{That}~~ **[The]** side of the cooling member 3 facing away from the printed circuit board 1 is preferably designed such that ~~{the}~~ heat output to the environment is maximized. To this end, this surface is blackened and/or provided with cooling ribs and/or implemented with some other suitable surface structure or roughening.

Figures 2A through C show how the invention can be advantageously utilized in order to manufacture specific three-dimensional lighting members. In all illustrated instances, a cooling member 3 having a desired shape is first prepared, whereby one surface should be fashioned as luminous surface by applying an LED arrangement composed of surface-mounted LEDs 2. A flexible printed circuit board 1 such as a flex board that is provided with an array of LEDs 2 is then laminated onto the cooling member 3.

In a side view, ~~{for example,}~~ Figure 2A shows an arbitrary curvature of a cooling member 3 that can be especially advantageously employed for an exterior vehicle illumination such as a blinker, a tail light ~~{or}~~**[,]** a brake light**[,]** or the like**[,]** since it can be adapted to the outside contour of the vehicle in a space-saving fashion. ~~{For example, the}~~ **[The]** cooling member can be directly formed by a partial surface region of an automobile chassis~~{(for example,}~~**[, such as]** the headlight or tail light region of the fenders**[,]** or a device housing ~~{or the like}~~.

The exemplary embodiment of Figure 2B shows an axial ~~{crossection}~~ **[cross-section]** through a rotating light of a type that can, ~~{for example,}~~ be employed in emergency vehicles~~{. Given to}~~**[, for example. For**

the] rotating light of Figure 2B, the flex board 1 **[is]** provided with an array of LEDs 2 is laminated around a tubularly shaped, cylindrical, hollow cooling member 3. In this exemplary embodiment, the LEDs of the array proceeding parallel to the axis can be additionally combined to form lanes that are successively driven in a clockwise direction~~{(see arrow)}~~, so that a rotating light is produced. At one point in time, one lane or a specific plurality of neighboring lanes can thereby be driven simultaneously. For bundling the emitted light, ~~{moreover,}~~ the LEDs 2 can be provided with lenses 5. This embodiment has the ~~{great}~~ advantage that practically all mechanical parts that have hitherto been needed for rotating lights of a conventional type are eliminated. As desired, the cylindrical cooling member 3 can also have a gas**[,]** such as air or a liquid coolant**[,]** flowing through it for further improvement of the heat elimination.

Figure 2C shows a perspective view of a three-dimensionally arced light dome. The light dome comprises a regular shape with an upper surface and four obliquely placed side surfaces, two respective side surfaces thereof ~~{being}~~ **[are]** arranged axially symmetrically relative to one another. The cooling member itself cannot be seen in the illustration of Figure 2C since it is completely covered by the flex board. The flex board 1 comprises a plurality of sectors corresponding to the surfaces of the cooling member and wherein a plurality of LEDs 2 arranged in an array are respectively mounted. ~~{As wanted, the}~~ **[The]** LEDs 2 can be provided with lenses for bundling the emitted light**[, as desired]**. Such a light dome can be utilized for all types of lighting purposes.

[Although modifications and changes may be suggested by those skilled in the art to which this invention pertains, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications that may reasonably and properly come under the scope of their contribution to the art. - -]

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Substitute Specification:

- - LED ARRANGEMENT

BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention is directed to LED (light emitting diode) arrangements. In particular, the present invention is directed to LED arrangements that can be built into a lamp housing or located in exterior lights of motor vehicles.

Brief Discussion of the Related Art:

In the field of exterior and interior illumination of motor vehicles, light-emitting diodes (LEDs) are being increasingly used instead of conventional incandescent bulbs, particularly for tail lights and brake lights, since LEDs have a longer service life, a better efficiency in the conversion of electrical energy into radiation energy in the visible spectral range and, connected therewith, a lower heat emission and a lower space requirement overall.

EP 0 253 224 discloses a method for the manufacture of a light with light-emitting diodes. The light to be manufactured comprises a soft plastic film on whose upper side a copper lamination is applied and a plurality of light-emitting diodes are arranged. The plastic film has its side lying opposite the upper side glued onto a metallic carrier plate. The light is provided for employment in a motor vehicle, whereby the carrier plate can be implemented bent for adaptation to the shape of a motor vehicle.

Further, US 5,782,555 discloses a traffic signal light that comprises a plurality of LEDs as luminous members. The LEDs are secured on the surface of a printed circuit board that is provided with a both-sided metallization. A plurality of through holes via which the metallizations are connected to one another are formed in the printed circuit board. The printed circuit board is secured with an adhesive to a cooling member that is provided with an electrically insulating surface.

US 5,890,794 discloses another lighting unit on the basis of LEDs. Here, a plurality of radial LEDs is mounted on a printed circuit board, whereby the wire leads are conducted through the printed circuit board in a traditional way. In one illustrated embodiment, the printed circuit board is flexible and applied onto a cylindrical member. A coolant fluid is preferably employed for cooling.

A certain added outlay must be incurred first when constructing a light with LEDs since, due to the low luminance of an individual LED compared to an incandescent bulb, a plurality of LEDs shaped to form an array must be constructed.

For example, such an array can be mounted using surface mounting technology (SMT) with a plurality of LEDs on a printed circuit board (PCB). Such an LED structure is described in the article "SIEMENS SMT-TOPLED für die Oberflächenmontage" by F. Möllmer and G. Waitl in the periodical Siemens Components 29 (1991), Number 4, page 147. The form

of the LEDs is extremely compact and allows the arrangement of a plurality of such LEDs in a row or matrix arrangement as warranted.

However, only approximately 5% of the electrical power is converted into light within the housing of such an LED that, for example, emits yellow-colored or amber-colored light, whereas approximately 95% is converted into heat. This heat is eliminated from the underside of the chip via the electrical terminal of the component. Dependent on the structure, the heat given the components known as TOPLED® or Power TOPLED® is first conducted out of the housing onto the solder points on the printed circuit board by one or three existing cathode terminals. From the solder points, the heat at first propagates in the copper pads and then on the epoxy resin material in the plane of the printed circuit board. Subsequently, the heat is output large-area to the environment by thermal radiation and thermal convection. The thermal resistance is still relatively slight in the case of a single LED on FR4 circuit board material (for example, approximately 180 K/W given an LED of the type Power TOPLED®).

The situation is different however, when many LEDs are arranged in close proximity on a circuit board. A smaller percentual area of the PCB is now available for each individual LED for heat transmission to the environment. The thermal resistance from the PCB onto the environment is correspondingly higher. For instance, given a components spacing of 6.5 mm, the thermal resistance rises to up to 550 K/W when the LEDs are of the Power TOPLED® type, and the printed circuit board is of the type FR4.

Heat is emitted from all heat-generating components on the circuit board, i.e. from the dropping resistors, transistors, MOSFETs, or drive ICs that are located in the immediate proximity of the LEDs. Operating current must be reduced so that destruction of the component does not occur as a consequence of heat generation on the circuit board and inadequate heat elimination. Thus, the luminous power of the LEDs cannot be fully exploited.

LED arrangements are utilized for the third brake light in the aforementioned field of motor vehicle lighting. This is a single-line array wherein the thermal problems are not yet so critical.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to improve an LED arrangement such that the luminous power of the LEDs can be as optimally utilized. In particular, an object of the present invention is to specify a surface-mounted LED arrangement that is distinguished by an improved heat elimination from the LEDs. In addition, an LED arrangement should be made available with which different spatial shapes of three-dimensional lamps can be realized in a simple way.

According to the invention, an LED arrangement with a printed circuit board and a plurality of LEDs -- surface-mounted LEDs are especially preferred -- is provided, whereby the printed circuit board has its side facing away from the LEDs applied on a cooling member and comprises a metallic layer with good thermal conductivity on this side that is electrically insulated from the LEDs by the printed circuit board. The present invention is thus

based on the perception that heat elimination toward the back must be promoted, particularly given a surface-mounted LED arrangement having a high LED density.

The cooling member can be composed of copper or aluminum or of a cooling plate, and the printed circuit board is preferably secured to it with a thermally conductive paste, a thermally conductive adhesive, a thermally conductive film or the like. It should enable an optimally good heat dissipation at its back side. To this end, for example, it can be painted black and/or comprise cooling ribs and/or a rough surface.

Further, the printed circuit board should be as thin as possible since the plastic material of which it is constructed usually conducts heat poorly. For example, the printed circuit board can be a flexible printed circuit board. The flexible printed circuit board is generally manufactured of a flexible plastic. For example, it can be composed of polyester or polyamide film, or it may comprise what is often referred to as flex-board. Flex board is generally multi-layer printed circuit boards that are uniformly constructed of a plurality of polyamide carrier films.

Further, the copper pads around the solder surfaces of LEDs applied with surface mounting technique (SMT) should be as large as possible in order to broaden the heat path through the printed circuit board material before the heat flows to the back side of the printed circuit board. Preferably, the principal face of the printed circuit board facing toward the cooling member is laminated with copper or some other metal in order to

enable thermal conduction transversely to other glue locations given cavities in the lamination. For example, the copper layer can be structured meander-shaped laterally to the printed circuit board in order to preserve the flexibility of the printed circuit board.

In an embodiment of the LED arrangement according to the present invention, a cooling member having a specific three-dimensional shape is employed, and a flexible printed circuit board having a principal face provided with a plurality of LEDs is laminated onto the surface of the cooling member shaped or curved in this way. As a result thereof, LED modules spatially shaped on the basis of specific particulars can be manufactured. For example, an LED module such as a blinker, tail light, brake light, or the like, can be adapted to the outside contour of the vehicle in a space-saving fashion. An especially practical exemplary embodiment of this type is a rotating light wherein LED arrays on flex boards are laminated around a cylindrical cooling member.

The LED arrangement of the present invention can preferably have its printed circuit board applied on a highly thermally conductive partial surface region of a device housing or of an automobile chassis or the like. Advantageously, the device housing or the automobile chassis thereby acts as cooling member. Among other things, this leads to a lower technological manufacturing outlay and to a weight-saving. Thus, the thermally conductive partial surface region serves as the cooling member in the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A shows a side view of an embodiment of the present invention;

Figure 1B shows a schematic of an embodiment of a thermally conductive layer according to the present invention; and

Figures 2A-2C shows other embodiments of the present invention with different shapes of cooling members.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

The embodiment of the present invention shown in Figure 1 contains a printed circuit board 1 on which a plurality of preferably surface-mounted LEDs 2 are applied. In a known way, the printed circuit board 1 thereby forms a circuit that comprises terminal surfaces for the mounting of the LEDs at defined locations. These terminal surfaces are provided, for example, with lands for soldering in an automatic surface mount device (SMD) equipping unit, and the LEDs 2 have their electrical contacts 2a soldered to these terminal surfaces in a subsequent mounting step.

The printed circuit board 1 can be a rigid printed circuit board, such as type FR4, and constructed of an epoxy resin material. However, it can also be a flexible printed circuit board such as an above-described flex board. The printed circuit board 1 is laminated onto a cooling member 3 with a thermally conductive adhesive, said cooling member 3 being composed of a cooling plate or being fabricated of some other metal such as copper or

aluminum, and thus exhibiting a high thermal conductivity.

The principal face of the printed circuit board 1 facing toward the cooling member is laminated with a layer 4 having good thermal conductivity, such as with a copper layer or some other metal layer in order to enable thermal conduction transversely to other glue locations given cavities in the lamination. The copper layer can be meander-shaped as shown in Figure 1B in order to preserve the flexibility of the printed circuit board.

The side of the cooling member 3 facing away from the printed circuit board 1 is preferably designed such that heat output to the environment is maximized. To this end, this surface is blackened and/or provided with cooling ribs and/or implemented with some other suitable surface structure or roughening.

Figures 2A through C show how the invention can be advantageously utilized in order to manufacture specific three-dimensional lighting members. In all illustrated instances, a cooling member 3 having a desired shape is first prepared, whereby one surface should be fashioned as luminous surface by applying an LED arrangement composed of surface-mounted LEDs 2. A flexible printed circuit board 1 such as a flex board that is provided with an array of LEDs 2 is then laminated onto the cooling member 3.

In a side view, Figure 2A shows an arbitrary curvature of a cooling member 3 that can be especially advantageously employed for an exterior vehicle illumination such as a blinker, a tail light, a brake light, or

the like, since it can be adapted to the outside contour of the vehicle in a space-saving fashion. The cooling member can be directly formed by a partial surface region of an automobile chassis, such as the headlight or tail light region of the fenders, or a device housing.

The exemplary embodiment of Figure 2B shows an axial cross-section through a rotating light of a type that can, be employed in emergency vehicles, for example. For the rotating light of Figure 2B, the flex board 1 is provided with an array of LEDs 2 is laminated around a tubularly shaped, cylindrical, hollow cooling member 3. In this exemplary embodiment, the LEDs of the array proceeding parallel to the axis can be additionally combined to form lanes that are successively driven in a clockwise direction, so that a rotating light is produced. At one point in time, one lane or a specific plurality of neighboring lanes can thereby be driven simultaneously. For bundling the emitted light, the LEDs 2 can be provided with lenses 5. This embodiment has the advantage that practically all mechanical parts that have hitherto been needed for rotating lights of a conventional type are eliminated. As desired, the cylindrical cooling member 3 can also have a gas, such as air or a liquid coolant, flowing through it for further improvement of the heat elimination.

Figure 2C shows a perspective view of a three-dimensionally arced light dome. The light dome comprises a regular shape with an upper surface and four obliquely placed side surfaces, two respective side surfaces thereof are arranged axially symmetrically relative to one another. The cooling

member itself cannot be seen in the illustration of Figure 2C since it is completely covered by the flex board. The flex board 1 comprises a plurality of sectors corresponding to the surfaces of the cooling member and wherein a plurality of LEDs 2 arranged in an array are respectively mounted. The LEDs 2 can be provided with lenses for bundling the emitted light, as desired. Such a light dome can be utilized for all types of lighting purposes.

Although modifications and changes may be suggested by those skilled in the art to which this invention pertains, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications that may reasonably and properly come under the scope of their contribution to the art. - -

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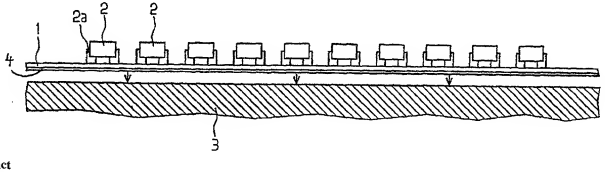
(54) Title: LIGHT–EMITTING DIODE ARRANGEMENT

(54) Bezeichnung: LED–ANORDNUNG



(57) Abstract

The invention relates to a light–emitting diode array that is surface–mounted on a board (1), such as a flexible board. The light–emitting diode array is mounted on a heat sink (3), so that the heat can be dissipated in an optimal manner. Said heat sink can take any form desired so that it is possible to design motor vehicle lamps, such as indicator lamps or similar, that can be adapted to the outer contour of the vehicle. In the case of a rotating lamp, the board (1) can be mounted around a heat sink that is configured as a cylindrical hollow body and can be operated rotationally.

(57) Zusammenfassung

Die Erfindung beschreibt ein auf einer Platine (1) wie einem Flexboard oberflächenmontiertes LED–Array, das auf einem Kühlkörper (3) aufgebracht ist, so daß die Wärme optimal abgeführt wird. Der Kühlkörper kann jede gewünschte Form aufweisen, so daß Kraftfahrzeugleuchten wie Blinker oder dergleichen konstruiert werden können, die der Außenkontur des Fahrzeugs angepaßt werden können. Bei einer Rundumleuchte kann die Platine (1) um einen als zylindrischen Hohlkörper ausgebildeten Kühlkörper angebracht werden und umlaufend betrieben werden.

LED ARRANGEMENT

The invention is directed to an LED arrangement according to the preamble of patent claim 1 that, in particular, can be built into a lamp housing as can be employed, for example, in exterior lights of motor vehicles.

In the field of exterior and interior illumination of motor vehicles, light-emitting diodes (LEDs) are being increasingly used instead of conventional incandescent bulbs, particularly for tail lights and brake lights, since LEDs have a longer service life, a better efficiency in the conversion of electrical energy into radiation energy in the visible spectral range and, connected therewith, a lower heat emission and a lower space requirement overall.

EP 0 253 224 discloses a method for the manufacture of a light with light-emitting diodes. The light to be manufactured comprises a soft plastic film on whose upper side a copper lamination is applied and a plurality of light-emitting diodes are arranged. The plastic film has its side lying opposite the upper side glued onto a metallic carrier plate. The light is provided for employment in a motor vehicle, whereby the carrier plate can be implemented bent for adaptation to the shape of a motor vehicle.

Further, US 5,782,555 discloses a traffic signal light that comprises a plurality of LEDs as luminous members. The LEDs are secured on the surface of a printed circuit board that is provided with a both-sided metallization. A plurality of through holes via which the metallizations are connected to one another are formed in the printed circuit board. The printed circuit board is secured with an adhesive to a cooling member that is provided with an electrically insulating surface.

US 5,890,794 discloses another lighting unit on the basis of LEDs. Here, a plurality of radial LEDs is mounted on a printed circuit board, whereby the wire leads are conducted through the printed circuit board in a traditional way. In one illustrated embodiment, the printed circuit board is flexible and applied onto a cylindrical member. A coolant fluid is preferably employed for cooling.

A certain added outlay must be incurred first when constructing a light with LEDs since, due to the low luminance of an individual LED compared to an incandescent bulb, a plurality of LEDs shaped to form an array must be constructed.

For example, such an array can be mounted [sic] in surface mounting technology (SMT, surface mount technology) from a plurality of LEDs on a printed circuit board (PCB). An LED structure as described, for example, in the article "SIEMENS SMT-TOPLED für die Oberflächenmontage" by F. Möllmer and G. Waitl in the periodical Siemens Components 29 (1991), Number 4, page 147 in conjunction with Figure 1 is thereby employed. The form of the LED is extremely compact and allows the arrangement of a plurality of such LEDs in a row or matrix arrangement as warranted.

However, only approximately 5% of the electrical power is converted in the form of light within the housing of such an LED that, for example, emits yellow-colored or amber-colored light, whereas approximately 95% is converted in the form of heat. This heat is eliminated from the underside of the chip via the electrical terminal of the component. Dependent on the structure, the heat given the components of the assignee known by the names TOPLED or Power TOPLED is first conducted our of the housing onto the solder points on the printed circuit board by one or three existing cathode terminals. From the solder points, the heat at first propagates in the copper pads and then on the epoxy resin material in the plane of the printed circuit board. Subsequently, the heat is output large-area to the environment by thermal radiation and thermal convection. The thermal resistance is still relatively slight in the case of a single LED on FR4 circuit board material (for example, approximately 180 K/W given an LED of the type Power TOPLED®).

The situation is different, however, when many LEDs are arranged in close proximity on a circuit board. A smaller percentual area of the PCB is now available for each individual LED for the heat transmission to the environment. The thermal resistance from the PCB onto the environment is correspondingly higher. Given a components spacing of, for example, 6.5 mm, the thermal resistance rises to

up to 550 K/W when the LEDs are of the type Power TOPLED and the printed circuit board is of the type FR4.

Heat is emitted from all heat-generating components on the circuit board, i.e. from the dropping resistors, transistors, MOSFETs or drive ICs as well, that are located in the immediate proximity of the LEDs. The operating current must be reduced so that a destruction of the component does not occur as a consequence of the hear generation on the circuit board and the inadequate heat elimination. The luminous power of the LEDs, accordingly, cannot be fully exploited.

LED arrangements are utilized for the third brake light in the aforementioned field of motor vehicle lighting. This is a single-line array wherein the thermal problems are not yet so critical.

It is therefore an object of the present invention to improve an LED arrangement of the species initially cited such that the luminous power of the LEDs can be as optimally utilized as possible. In particular, an object of the present invention is to specify a surface-mounted LED arrangement that is distinguished by an improved heat elimination from the LEDs. In addition, an LED arrangement should be made available with which different spatial shapes of three-dimensional lamps can be realized in a simple way.

This object is achieved by an LED arrangement having the features of patent claim 1. Advantageous developments of the invention and preferred lighting devices having inventive LED arrangements are the subject matter of patent claims 2 through 14.

According to the invention, an LED arrangement with a printed circuit board and a plurality of LEDs -- surface-mounted LEDs are especially preferred -- is provided, whereby the printed circuit board has its side facing away from the LEDs applied on a cooling member and comprises a metallic layer with good thermal conductivity on this side that is electrically insulated from the LEDs by the printed circuit board. The invention is thus based on the perception that the heat elimination toward the back must be promoted, particularly given a surface-mounted LED arrangement having a high LED density.

The cooling member can, for example, be composed of copper or aluminum or of a cooling plate, and the printed circuit board is preferably secured on it with a thermally conductive paste, a thermally conductive adhesive, a thermally

conductive film or the like. It should enable an optimally good heat dissipation at its back side. To this end, for example, it can be painted black and/or comprise cooling ribs and/or a rough surface.

Further, the printed circuit board should be as thin as possible since the plastic material of which it is constructed usually conducts heat poorly. For example, the printed circuit board can be a flexible printed circuit board. The flexible printed circuit board is generally manufactured of a flexible plastic. For example, it can be composed of polyester or polyimide film. The employment of what are referred to as flex boards, which are notoriously known in the Prior Art, is especially preferred. These flex boards are generally multi-layer printed circuit boards that are uniformly constructed of a plurality of polyimide carrier films.

Further, the copper pads around the solder surfaces of LEDs applied with surface mounting technique (SMT) should be as large as possible in order to broaden the heat path through the printed circuit board material before the heat flows to the back side of the printed circuit board. Preferably, the principal face of the printed circuit board facing toward the cooling member is laminated with copper or some other metal in order to still enable thermal conduction transversely to other glue locations given cavities in the lamination. For example, the copper layer can be

can be adapted to the outside contour of the vehicle in a space-saving fashion. For example, the cooling member can be directly formed by a partial surface region of an automobile chassis (for example, the headlight or tail light region of the fenders) or a device housing or the like.

The exemplary embodiment of Figure 2B shows an axial crossection through a rotating light of a type that can, for example, be employed in emergency vehicles. Given to rotating light of Figure 2B, the flex board 1 provided with an array of LEDs 2 is laminated around a tubularly shaped, cylindrical, hollow cooling member 3. In this exemplary embodiment, the LEDs of the array proceeding parallel to the axis can be additionally combined to form lanes that are successively driven in a clockwise direction (see arrow), so that a rotating light is produced. At one point in time, one lane or a specific plurality of neighboring lanes can thereby be driven simultaneously. For bundling the emitted light, moreover, the LEDs 2 can be provided with lenses 5. This embodiment has the great advantage that practically all mechanical parts that have hitherto been needed for rotating lights of a conventional type are eliminated. As desired, the cylindrical cooling member 3 can also have a gas such as air or a liquid coolant flowing through it for further improvement of the heat elimination.

Figure 2C shows a perspective view of a three-dimensionally arced light dome. The light dome comprises a regular shape with an upper surface and four obliquely placed side surfaces, two respective side surfaces thereof being arranged axially symmetrically relative to one another. The cooling member itself cannot be seen in the illustration of Figure 2C since it is completely covered by the flex board. The flex board 1 comprises a plurality of sectors corresponding to the surfaces of the cooling member and wherein a plurality of LEDs 2 arranged in an array are respectively mounted. As wanted, the LEDs 2 can be provided with lenses for bundling the emitted light. Such a light dome can be utilized for all types of lighting purposes.

New Patent Claims

1. Surface-mounted LED arrangement with

-- a printed circuit board (1) composed of a plastic material,

-- a plurality of LEDs (2) that are arranged on a principal surface of the printed circuit board (1), and

-- a metallic layer (4) with which the printed circuit board (1) is provided on that side facing away from the LEDs,

characterized in that

-- a cooling member (3) is connected to that side of the printed circuit board (1) facing away from the LEDs (2), and

-- the printed circuit board (1) is secured on the cooling member with a thermally conductive paste, a thermally conductive adhesive or a thermally conductive film.

8. LED arrangement according to one of the claims 1 through 7, characterized in that the LEDs (2) are provided with lenses (5).

9. LED arrangement according to one of the claims 1 through 8, characterized in that the printed circuit board (1) electrically insulates the metallic layer (4) from the LEDs (2).

10. LED arrangement according to one of the claims 1 through 9, characterized in that the printed circuit board (1) is composed of FR4, an epoxy resin, a polyester or a polyimide, preferably in the form of a polyester or polyimide film.

11. Lighting device having an LED arrangement according to one of the claims 1 through 10.

12. Lighting device having an LED arrangement according to one of the claims 1 through 10, characterized in that

New Patent Claims

1. Surface-mounted LED arrangement with

-- a printed circuit board (1),

-- a plurality of LEDs (2) that are arranged on a principal surface of the printed circuit board (1), and

-- a cooling member (3) that is connected to that side of the printed circuit board (1) facing away from the LEDs (2),

characterized in that

-- the printed circuit board (1) has its principal surface facing toward the cooling member (3) provided with a metallic layer (4), whereby the printed circuit board (1) electrically insulates the metallic layer (4) from the LEDs.

2. LED arrangement according to claim 1, characterized in that the metallic layer (4) contains copper or other metal with good thermal conductivity.

3. LED arrangement according to claim 1 or 2, characterized in that the printed circuit board (1) is a flexible printed circuit board, particularly a flex board.

4. LED arrangement according to claim 3, characterized in that the printed circuit board (1) has its side facing away from the LEDs (2) applied onto a curved or singly or multiply angled-off surface of a cooling member (3) or of a highly thermally conductive partial region of a device housing or of an automobile chassis or the like such that the plurality of LEDs (2) are arranged in a spatial form determined by the curved or singly or multiply angled-off surface of the cooling member (3) or the like.

5. LED arrangement according to one of the claims 1 through 4, characterized in that the metallic layer(4) comprises a meander-like lateral structure.

6. LED arrangement according to one of the claims 1 through 5, characterized in that the cooling member (3) is composed of metal, particularly of copper or aluminum or a sheet metal.

7. LED arrangement according to one of the claims 1 through 6, characterized in that the surface of the cooling member (3) that faces away from the printed circuit board (1) is blackened and/or comprises cooling ribs and/or a surface roughening.

8. LED arrangement according to one of the claims 1 through 7, characterized in that the LEDs (2) are provided with lenses (4) [sic].

9. LED arrangement according to one of the claims 1 through 8, characterized in that the printed circuit board (1) is secured on the cooling member with a thermally conductive paste, a thermally conductive adhesive or a thermally conductive film.

10. Lighting device having an LED arrangement according to one of the claims 1 through 9.

11. Lighting device having an LED arrangement according to one of the claims 1 through 9, characterized in that

-- it is an exterior lighting of a motor vehicle such as a blinker, a tail light or a brake light, and

-- the cooling member (3) comprises a curvature adapted to the outside contour of the motor vehicle or is a partial surface region of an automobile chassis.

-- it is an exterior lighting of a motor vehicle such as a blinker, a tail light or a brake light, and

-- the cooling member (3) comprises a curvature adapted to the outside contour of the motor vehicle or is a partial surface region of an automobile chassis.

13. Lighting device having an LED arrangement according to one of the claims 1 through 10, characterized in that

-- it is a rotating light, and

-- the cooling member (3) is a cylindrical hollow member to whose outside wall the printed circuit board (1) is applied.

14. Lighting device according to claim 11, characterized in that LEDs of the array that proceed axially parallel are electrically combined into lanes that can be successively circumferentially operated.

15. Lighting device having an LED arrangement according to one of the claims 1 through 3, characterized in that

-- it is an exterior lighting of a motor vehicle such as a blinker, a tail light, a brake light or the like, and

-- the cooling member (3) comprises a curvature adapted to the outside contour of the motor vehicle or is a partial surface region of an automobile chassis.

16. Lighting device according to one of the claims 1 through 13, characterized in that

-- it is a rotating light, and

-- the cooling member (3) is a cylindrical hollow member to whose outside wall the printed circuit board (1) is applied.

17. Lighting device according to claim 16, characterized in that LEDs of the array that proceed axially parallel are electrically combined into lanes that can be successively circumferentially operated.

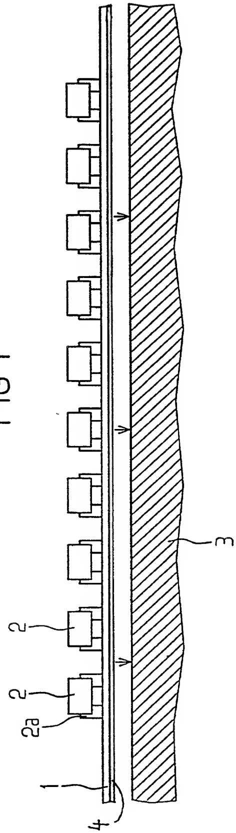


FIG 1

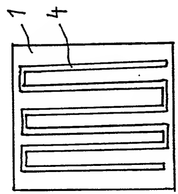


FIG 1B

FIG 2A

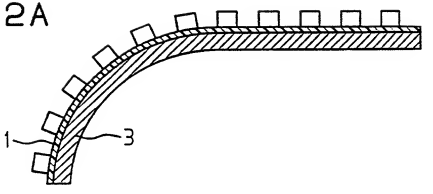


FIG 2B

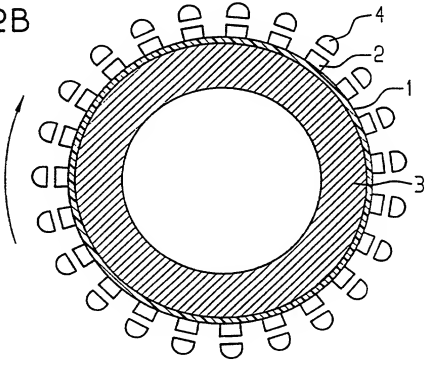
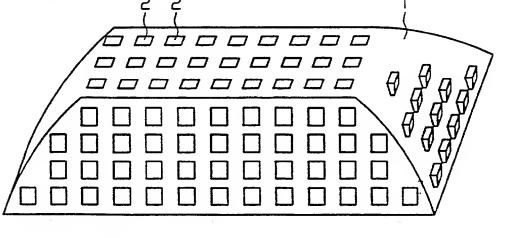


FIG 2C



German Language Declaration

Prior foreign applications
Priorität beansprucht

			Priority Claimed	
199 22 176.6	Germany	12 May 1999	☒	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein

Ich beanspruche hiermit germäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122 I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.) (Anmeldeseriennummer)	(Filing Date) (Anmeldedatum)	(Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date) (Anmeldedatum)	(Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION
ERKLÄRUNG FÜR PATENTANMELDUNGEN MIT VOLLMACHT
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für des dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

(zutreffendes ankreuzen)

☐ hier beigefügt ist.

☒ am _____ als PCT internationale Anmeldung PCT Anmeldungsnummer _____ eingereicht wurde und am _____ abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56 von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

LIGHT-EMITTING DIODE ARRANGEMENT

the specification of which

(check one)

☐ is attached hereto

☒ was filed on May 12, 2000 as United States application Number or PCT international application Number PCT/DE00/01508 and was amended on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: (Name und Registrationsnummer anführen)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

And I hereby appoint all Attorneys Identified by United States Patent & Trademark Office Customer Number 26574, who are all members of the firm of Schiff Hardin and Waite.

Telephone 312/-258-5500 Patent Department

my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and direct that all correspondence be forwarded to:

Schiff, Hardin & Waite
Atten: Patent Department
6600 Sears Tower, Chicago, Illinois 60606 -6473
Customer Number 26574

Voller Name des einzigen oder ursprünglichen Erfinders:	Full name of sole or first inventor: KARLHEINZ ARNDT
Unterschrift des Erfinders Datum	Inventor's signature Date 12/4/2001
Wohnsitz	Residence Regensburg, Germany
Staatsangehörigkeit	Citizenship Germany
Postanschrift	Post Office Address Bayerwaldstr. 13
	D 93059 Regensburg, Germany

Voller Name des zweiten Miterfinders (falls zuttreffend):	Full name of second joint inventor, if any: GUENTER WAITL
Unterschrift des Erfinders Datum	Inventor's signature Date 12/04/2001
Wohnsitz	Residence Regensburg, Germany DAX
Staatsangehörigkeit	Citizenship Germany
Postanschrift	Post Office Address Praschweg 3
	D93049 Regensburg, Germany
Voller Name des dritten Miterfinders (falls zuttreffend):	Full name of third joint inventor, if any: GEORG BOGNER
Unterschrift des Erfinders Datum	Inventor's signature Date 12/04/2001
Wohnsitz	Residence Lappersdorf, Germany DAX
Staatsangehörigkeit	Citizenship Germany
Postanschrift	Post Office Address Am Sandbügel 12
	D93138 Lappersdorf, Germany
Voller Name des vierten Miterfinders (falls zuttreffend):	Full name of fourth joint inventor, if any:
Unterschrift des Erfinders Datum	Inventor's signature Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address

(Bitte entsprechende Informationen und Unterschriften im Falle von zweiten und weiteren Miterfindern angeben).

(Supply similar information and signature for second and subsequent joint inventors).

Rec'd PCT/PTO 26 MAR 2002 #5
10/0000564 C. Brut

U.S. APPLICATION NO. (if known, see 37 C F R 1 5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/009,656	**PCT/DE00/01508**	**P01,0404**

17. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5): Search Report has been prepared by the EPO or JPO $890 00		
International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) $710.00		
No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2) $740.00		
Neither international preliminary examination fee (37 C.F.R. 1 482) nor international search fee (37 C.F.R. 1.445(a)(2) paid to USPTO $1040.00		
International preliminary examination fee paid to USPTO (37 C.F R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $ 100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 C.F R. 1.492(e)).	$ 130.00	

Claims	Number Filed		Number Extra	Rate		
Total Claims	17	- 20 =	0	X $ 18.00	$	
Independent Claims	01	- 3 =	0	X $ 84.00	$	
Multiple Dependent Claims				$280.00 +	$	
				TOTAL OF ABOVE CALCULATIONS =	$	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)					$	
				SUBTOTAL =	$ 130.00	
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +					$	
				TOTAL NATIONAL FEE =	$	
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). $40.00 per property +						
				TOTAL FEES ENCLOSED =	$ 130.00	
03/29/2002 MALI11 00000040 10009656				Amount to be refunded	$	
01 FC:154 130.00 DP				charged	$	

a. ☒ A check in the amount of $130.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **50-1519**. **A duplicate copy of this sheet is enclosed.**

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

SCHIFF HARDIN & WAITE
PATENT DEPARTMENT
6600 Sears Tower
233 South Wacker Drive
Chicago, Illinois 60606-6473

CUSTOMER NUMBER 26574

Mark Bergner
Signature **Mark Bergner** **Attorney for Applicants**

Registration No. 45,877

Dated: March 26, 2002